4. (Original) The manufacturing method of an arc tube of Claim 1, wherein

the mandrel is disposed beneath a substantially center of a double spiral scheduled portion, which is such a portion of the glass tube that is to be formed into the double spiral, and

an axis of the mandrel extends substantially perpendicularly.

5. (Original) The manufacturing method of an arc tube of Claim 1, wherein

the glass tube is substantially straight before the softening step, and

the glass tube, being substantially straight, is held by ends thereof so that a tube axis of the glass tube is substantially horizontal.

6. (Original) The manufacturing method of an arc tube of Claim 1, wherein

while the glass tube is substantially perpendicularly lowered, a portion in a vicinity of a center of a double spiral scheduled portion sags downward, the double spiral scheduled portion being such a portion of the glass tube that is to be formed into the double spiral.

7. (Original) The manufacturing method of an arc tube of Claim 1, wherein

the mandrel has, on a periphery thereof, winding grooves that correspond to the double spiral, and

a double spiral scheduled portion, which is such a portion of the glass tube that is to be formed into the double spiral, is positioned parallel with the winding grooves when viewed from a direction orthogonal to an axis of the mandrel, before the double spiral scheduled portion is wound along the winding grooves.

8. (Original) The manufacturing method of an arc tube of Claim 7, wherein

ends of the glass tube are held by chuck units, and

the double spiral scheduled portion is positioned parallel with the winding grooves by moving the chuck units in a direction that make the chuck units farther apart from each other, along a line that connects one of the chuck units with the other of the chuck units when viewed from a direction toward which an axis of the mandrel extends.

9. (Original) The manufacturing method of an arc tube of Claim 2, wherein

at least one pair of supporting rollers for supporting the double spiral scheduled portion is provided in a vicinity of the mandrel, and

the glass tube being in a soft state is substantially perpendicularly lowered so that the glass tube is disposed across the pair of supporting rollers.

10. (Original) A manufacturing method of an arc tube in which a glass tube is formed into a double spiral by being wound around a mandrel, the manufacturing method comprising:

a softening step of softening the glass tube by heat;

a hanging and holding step of hanging and holding the softened glass tube, by a substantially center thereof, on a top of the mandrel; and

a winding step of winding the glass tube on a periphery of the mandrel so that the glass tube is formed into the double spiral, wherein

ends of the glass tube being in a soft state are held by chuck units which each move toward the mandrel as the glass tube is wound around the mandrel, and

a first speed at which the glass tube is wound around the mandrel in the winding step is higher than a second speed at which the chuck units move.

11. (Original) The manufacturing method of an arc tube of Claim 10, wherein

a ratio of the second speed to the first speed is no smaller than 0.6 and is smaller than 1.0.

12. (Original) The manufacturing method of an arc tube of Claim 1, wherein

the glass tube being in a soft state is guided into winding grooves of the mandrel by a pair of guiding rollers provided in a vicinity of the mandrel.

13. (Original) The manufacturing method of an arc tube of Claim 12, wherein

the pair of guiding rollers is positioned so that an axis of each guiding roller is inclined at an angle of

$\pi/2-\alpha$ to an axis of the mandrel, where α is an angle at which each of the winding grooves is inclined to the axis of the mandrel.

14. (Original) The manufacturing method of an arc tube of Claim 10, wherein

the glass tube being in the soft state is guided into winding grooves of the mandrel by a pair of guiding rollers provided in a vicinity of the mandrel.

15. (Original) The manufacturing method of an arc tube of Claim 14, wherein

the pair of guiding rollers is positioned so that an axis of each guiding roller is inclined at an angle of

$\pi/2-\alpha$ to an axis of the mandrel, where α is an angle at which each of the winding grooves is inclined to the axis of the mandrel.

16. (Original) The manufacturing method of an arc tube of Claim 1, wherein

while the glass tube is wound in the winding step, a gas for inflating the gas tube is sent into the glass tube being hung and held on the top of the mandrel, and

when the glass tube finishes being wound, a gas for cooling down the glass tube is sent into the glass tube.

17. (Original) The manufacturing method of an arc tube of Claim 10, wherein

while the glass tube is wound in the winding step, a gas for inflating the gas tube is sent into the glass tube being hung and held on the top of the mandrel, and

when the glass tube finishes being wound, a gas for cooling down the glass tube is sent into the glass tube.

18. -19. (Cancelled)

20. (New) A manufacturing method of an arc tube in which a glass tube is formed into a double spiral by winding around a mandrel comprising the steps of;

providing a predetermined length of an elongated straight glass tube;

supporting the respective end portions of the glass tube with an intermediate portion of the glass tube unsupported;

heating the intermediate portion of the glass tube until it is soft enough to sag by gravity forces;

lowering the heated glass tube until the sagging intermediate portion engages a mandrel with grooves representative of the double spiral configuration;

winding the heated glass tube about the mandrel to provide the double spiral configuration; and

removing the formed double spiral arc tube from the mandrel.

21. (New) The manufacturing method of an arc tube of Claim 20 further comprising applying a tension force to the intermediate portion of the glass tube sufficient to maintain a constant glass tube diameter during the winding step.

22. (New) The manufacturing method of an arc tube of Claim 21 wherein the tension force is applied by aligning the end portion of the glass tube with an angle of the double spiral configuration and maintaining a ratio of a moving speed of the end portions toward the mandrel to a winding speed of the mandrel from 0.6 to less than 1.0.

23. (New) The manufacturing method of an arc tube of Claim 20 further comprising applying a gas pressure into the sagging intermediate portion of the glass tube during the winding step.